

## Feature Story

### Bitter is Bigger Than Just a Bad Taste in Your Mouth: How a Tiny Genetic Mutation is Helping Us Map Human Migration Out of Africa

By Robin Latham

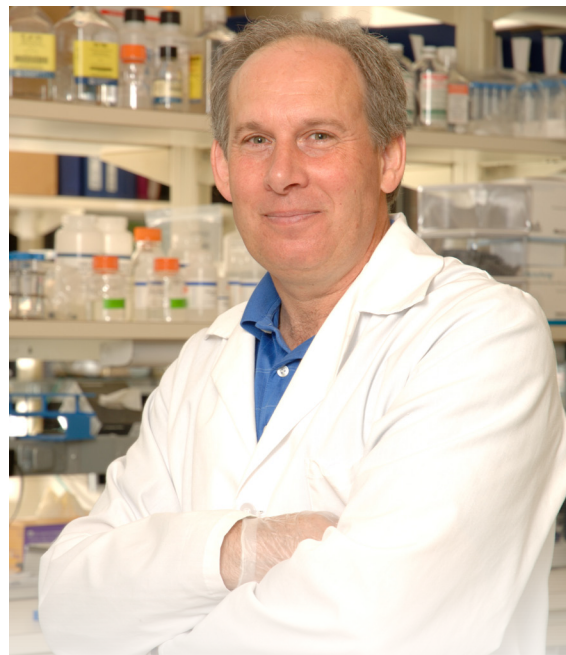
For someone who studies things that are very small, Dennis Drayna thinks big. A seemingly run-of-the-mill discussion on the molecular underpinnings of bitter taste receptors can quickly veer into a story about the migrations of ancient peoples out of Africa 70 thousand years ago. Remarkably, we can learn about more than just tastebuds by trying to figure out why some people taste bitter and others don't.

Taste receptors are located on specialized taste cells that bundle together within a taste bud on the surface of the human tongue. Taste receptors are able to sense five basic tastes: sweet, sour, bitter, salty, and umami, which is the savory flavor we get from foods rich in glutamate, such as meat and cheese. The ability to taste bitter may be the most important, says Dr. Drayna, who is chief of the Section on Systems Biology of Communication Disorders in the Laboratory of Molecular Genetics at the NIDCD. "The reason why we have a sense of bitter taste is to protect us from ingesting toxic substances, primarily in plants."

Variation in the ability to taste bitter substances was discovered by accident in the 1930s when a DuPont chemist found that crystals of a substance called PTC (phenylthiocarbamide) tasted very bitter to some people but were tasteless to others. Population studies of the numbers of tasters versus non-tasters revealed that about 75 percent of us perceive PTC as very bitter, while the remaining 25 percent don't. This informed a body of research that initially proposed that non-tasters inherited the trait as a recessive gene.

As it turns out, it wasn't that simple. In 2003, Dr. Drayna and his team of researchers at the NIDCD identified three variants in a gene that eventually came to be called TAS2R38. If you have two copies of this variant form, you are a non-taster. If you don't, you would find PTC very bitter indeed.

However, the TAS2R38 gene had even more to tell us than just whether or not we are able to taste something as bitter. In studying the genetic code



Dr. Dennis Drayna

of TAS2R38, Dr. Drayna and his colleagues found that the non-taster variant was what scientists call a "founder gene," in which the genetic variation is derived from a single ancestral individual, long lost in prehistory. They can tell this because the TAS2R38 variant is embedded in a larger piece of DNA that is identical in everyone else carrying that variant, in addition to the founder of a population. This suggests that all non-tasters, everywhere in the world, descended from the same individual.

The team then performed a bit of genetic detective work. Measuring the length of the stretch of DNA that surrounds the founder variant—the shorter it is, the older the gene—and determining who currently carries the founder

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variant and where they live, Dr. Drayna and his colleagues could estimate the approximate date at which the variant first appeared. They then followed its migration through time and space to trace the history of human migration out of Africa and into the rest of the world.

"Perhaps as few as a couple hundred people left Africa 70 thousand years ago and they spread rapidly," says Dr. Drayna. "At least one of them had to have the TAS2R38 mutation, and in the course of thousands of years, the mutation was passed on over and over again," and thus the non-taster form of the TAS2R38 gene became common worldwide.

Looking at patterns of variation in the TAS2R38 gene among Africans, Asians, and Europeans today reveals that the most variations for the PTC gene—seven different forms—were found in sub-Saharan Africa. Only two of these, called the major taster form and the major non-taster form, exist in high numbers in populations outside of sub-Saharan Africa. These appear to be the two major forms that emerged from Africa and rapidly spread around the world.

As much as taste research can tell us about human migration, it can tell us even more about the nature of food preferences and it has a key role to play in advances in other fields of study. "Half of the mechanics of taste is genetic, the other half is a combination of other factors," says Dr. Drayna. "Now we've got our hands on half of it—the genetic part. Gaining an understanding of the underlying genetic differences in taste perception, we can help untangle all sorts of other studies, not only for food preferences and consumption, but also studies that have to do with nutrition research, obesity research, and metabolic research."

Learn more about Dr. Drayna's research at <http://www.nidcd.nih.gov/research/scientists/draynad.asp>. Read NIDCD fact sheets on smell at <http://www.nidcd.nih.gov/health/smelltaste/smell.asp> and taste at <http://www.nidcd.nih.gov/health/smelltaste/taste.asp>.

## Smell Study Asks: Do People Perceive Some Odors Differently?



Charles J. Wysocki, Ph.D.  
Photo by Paola Nogueras

Charles J. Wysocki, Ph.D., an NIDCD-supported researcher at the Monell Chemical Senses Center in Philadelphia, is investigating genetic differences in smell perception. He and his team are testing a large population of Caucasian and African-American volunteers on their sensitivity to a dozen different smells, or odorants, looking for differences in the expression of specific genes that are associated with individual odor preferences. Some of the compounds being tested are found in food and fragrance products, and others are naturally occurring body odors.

Volunteers are brought into the laboratory and tested for their sensitivity to the odorants. Their DNA is sampled and scanned for the presence of a subset of genes in the olfactory receptor gene family that appear to show variation in people.

Over the course of the project, Dr. Wysocki says, they've begun to focus on a smaller group of olfactory receptor genes and their associated odorants and are testing them to determine whether or not the genes actually show activation in the presence of the odorant. "If it's a pleasant smelling odorant, or something that's beneficial," says Dr. Wysocki, "a chemist could modify the molecules to build a better binding area to the receptor." In other words, to make it smell even better. "If the odorants are unpleasant," he continues, "molecules could be altered to interact with the receptor and block the perception of nasty smelling substances." Dr. Wysocki imagines this kind of technology being used in a device that would plug into the wall to release molecules that block unpleasant smells. "People living downwind of agricultural settings, such as a hog farm, might like to have something like that."

Learn about Dr. Wysocki's research at [http://www.monell.org/faculty/people/charles\\_j\\_wysocki](http://www.monell.org/faculty/people/charles_j_wysocki).

## Recent Research and News

### Proteins Linked to Congenital Deafness Help Build, Maintain Stereocilia in the Inner Ear

If the inner ear were a city, then stereocilia could be considered the flashy, high-rise buildings making up the skyline. Protruding from the tops of sensory cells, called hair cells, inside the inner ear, stereocilia are composed of long filaments of actin, a robust protein that also assists in muscle contraction, cell division, and other cellular activities. They are also the site at which sound vibrations entering the ear are converted into electrical signals that travel to the brain, so scientists want to know more about how stereocilia are constructed.

NIDCD researcher Bechara Kachar, M.D., and others have now learned that two proteins that have been implicated in some forms of inherited deafness are responsible for building and maintaining these exquisitely formed structures. The research is published in the March 15, 2009, advance online publication of *Nature Cell Biology* at <http://www.nature.com/ncb/journal/v11/n4/abs/ncb1851.html>.

Read the NIDCD article on the Web at [http://www.nidcd.nih.gov/news/releases/09/03\\_16\\_09.htm](http://www.nidcd.nih.gov/news/releases/09/03_16_09.htm). Learn more about Dr. Kachar's research at <http://www.nidcd.nih.gov/research/scientists/kacharb.asp>.

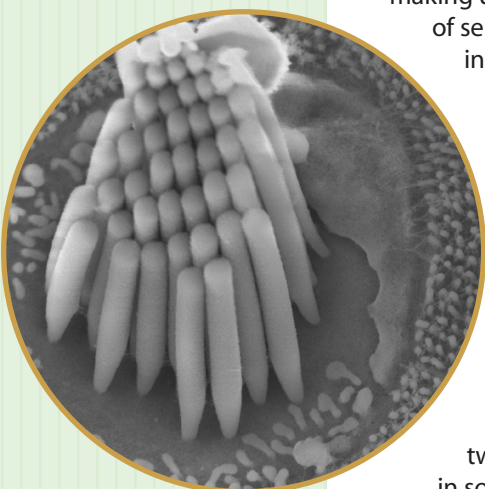
*While most of the credit for detecting sound is paid to the hair cells in our inner ear, a membrane that lies immediately above these cells, called the tectorial membrane, could be playing a larger role in the hearing process than scientists once thought.*

### New Research Shows Tectorial Membrane Plays a More Active Role in Helping Us Hear

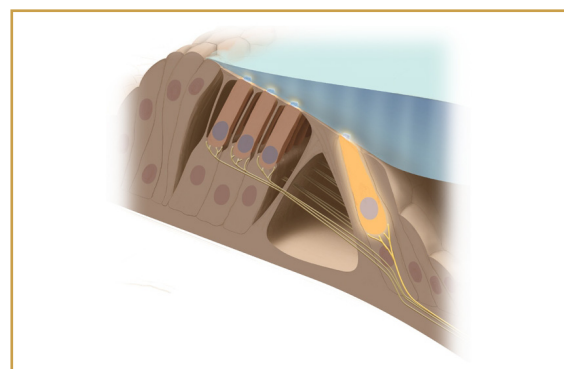
When you play a piano, the strings may supply the musical tones, but if it weren't for the wooden hammers striking the strings, you wouldn't hear a note. New research from the NIDCD suggests that the ear may be built in much the same way. While most of the credit for detecting sound is paid to the hair cells in our inner ear, a membrane that lies immediately above these cells, called the tectorial membrane, could be playing a larger role in the hearing process than scientists once thought.

In a study published in the March 18, 2009, issue of the journal *PLoS ONE* (<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0004877>), Richard Chadwick, Ph.D., and Nria Gava, Ph.D., both of the NIDCD's Auditory Mechanics Section, used nanotechnology techniques to devise a new method for studying the properties of the tectorial membrane. They wanted to test how soft or stiff the membrane is along the cochlea, and how these properties might affect a hair cell's ability to convert sound vibrations into an electrical signal.

Read the NIDCD Web article at [http://www.nidcd.nih.gov/news/releases/09/03\\_18\\_09.htm](http://www.nidcd.nih.gov/news/releases/09/03_18_09.htm). Learn more about Dr. Chadwick's and Gava's research at [www.nidcd.nih.gov/research/scientists/chadwickr.asp](http://www.nidcd.nih.gov/research/scientists/chadwickr.asp).



Scanning electron micrograph of the surface of the frog inner ear sensory epithelium showing the staircase-shaped stereocilia towering above other surface structures. Bar equals 1  $\mu$ m. Photo courtesy of C. Graydon and L. Andrade, NIDCD.



A "column" of three outer hair cells and one inner hair cell beneath the tectorial membrane (blue). Roughly 3,500 such columns wind their way along the cochlear spiral, with each column processing a different sound frequency.



## NIDCD Highlights

### NIDCD Names Dr. Andrew Griffith as Scientific Director

Andrew Griffith, M.D., Ph.D., chief of the Molecular Biology and Genetics Section and the Otolaryngology Branch at the NIDCD, has been appointed the institute's new scientific director. Dr. Griffith succeeds Robert J. Wenthold, Ph.D., who will remain chief of the Section on Neurotransmitter Receptor Biology in the Laboratory of Neurochemistry.



Dr. Andrew Griffith with researchers in his lab.

"Dr. Griffith is an exceptional clinician and scientist who has made major advances in identifying genes associated with hereditary hearing loss," said NIDCD director James F. Battey, Jr., M.D., Ph.D. "We're fortunate to have someone with his experience at NIH continuing to build on the strong research foundation laid down by Dr. Wenthold."

Dr. Griffith earned his M.D. and Ph.D. in molecular biophysics and biochemistry at Yale University, and went on to complete his residency in otolaryngology-head and neck surgery at the University of Michigan Medical School. He arrived at the NIDCD in 1998 as a research fellow with a clinical and basic scientific interest in hearing and balance, and became a tenure-track investigator in 2000. He was tenured and appointed chief of the Otolaryngology Branch in 2006. Among many other honors, Dr. Griffith has been awarded the M.D./Ph.D. Prize for Outstanding Graduate of the Medical Scientist Training Program at Yale in 1992, and the Presidential Early Career Award for Scientists and Engineers (PECASE) in 2002.

Dr. Griffith plans to continue the strong program of research in the mission areas of hearing, balance, smell, taste, voice, speech, and language already established at the NIDCD. He also hopes to build up the clinical research program and increase the diversity of investigators.

"Since I'm a clinician," Dr. Griffith said, "I'm sensitive to the importance of trying to translate basic discoveries into things that benefit patients."

Learn more about Dr. Griffith's research at <http://www.nidcd.nih.gov/research/scientists/griffith.asp>.

### NIDCD Welcomes Five New Members to Its Advisory Council

NIDCD director James F. Battey, Jr., M.D., Ph.D., welcomed five new members to the National Deafness and Other Communication Disorders (NDOD) Advisory Council during its regular meeting on June 5, 2009, at the NIH. The Council advises the secretary of the U.S. Department of Health and Human Services, the director of the NIH, and the director of the NIDCD on matters relating to the conduct and support of research and research training, health information dissemination, and other programs with respect to disorders of hearing and other communication processes. The term for Council members is four years.



Top row, left to right: Dr. James Battey, Dr. Rickie Davis, Dr. William Brownell, Dr. John Niparko. Bottom row, left to right: Dr. Karen Friderici, Ms. Brenda Battat.

The new members are: Brenda Battat, M.A., executive director of the Hearing Loss Association of America; William Brownell, Ph.D., chair in the Department of Otorhinolaryngology and Communicative Science at Baylor College of Medicine, in Houston; Karen Friderici, Ph.D.,

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professor in the Department of Microbiology and Molecular Genetics at Michigan State University in East Lansing; John Niparko, M.D., professor and director of the Division of Otolaryngology, Neurotology, and Skull Base Surgery in the Department of Otolaryngology–Head and Neck Surgery at the Johns Hopkins Hospital, Baltimore; and Rickie Davis, Ph.D., who leads the Hearing Loss Prevention Team at the National Institute for Occupational Safety and Health in the Centers for Disease Control and Prevention.

To learn more about the NIDCD Advisory Council and its new members, visit <http://www.nidcd.nih.gov/about/groups/ndcdac> or read the NIDCD article on the Web at [http://www.nidcd.nih.gov/news/releases/09/06\\_09\\_09.htm](http://www.nidcd.nih.gov/news/releases/09/06_09_09.htm).

## Concert Teaches Kids to Enjoy Tunes Safely

More than a thousand first- and second-graders from 14 public and private schools in the Washington, D.C., metropolitan area joined award-winning musical artist Billy Jonas and his band for an hour-long interactive concert about how to protect their hearing. The concert was held at George Washington University's Lisner Auditorium on April 29th.

As Jonas and his band pounded out the beat and strummed the melody on instruments rigged out of reused household gadgets, kids were clapping and stomping and making up their own lyrics to a song about how to protect their hearing now, so they don't lose it later. Their song began with a simple tip—"if the music's too loud you've got to turn it down," and ended with the reason why—"to protect your hearing so you'll enjoy the sound."

The concert was presented by the American Speech–Language–Hearing Association (ASHA) in collaboration with Parents' Choice Foundation and the NIDCD, along with media sponsor Sirius XM Radio. The concert, which is part of ASHA's "Listen to Your Buds" campaign (<http://www.listentoyourbuds.org>), helped kick off Better Hearing and Speech Month, a month-long celebration by ASHA and other organizations to raise awareness of, and promote treatment for, hearing and speech disorders.

Recently, ASHA became the first organization to partner with the NIDCD's *It's a Noisy Planet. Protect Their Hearing* (<http://www.noisyplanet.nidcd.nih.gov>) campaign, which encourages the parents of tweens (children ages 8 to 12) to teach their children about noise-induced hearing loss and how to protect their hearing for life.



**"All Together!"** Award-winning recording artist Billy Jonas led the kids in an engaging, interactive sing-a-long with lyrics aimed at teaching them safe listening habits for lifelong healthy hearing.  
(Photo Credit: ASHA)



**"Turn It Down!"** There was singing and cheering and glowstick waving as Billy Jonas and his band turned the kids' own ideas into a catchy song about all the things they can do to protect their hearing.  
(Photo Credit: ASHA)

## Grants News

### NIDCD Awards ARRA Dollars



The American Recovery and Reinvestment Act was enacted February 17, 2009, to jumpstart the economy, create and save jobs, and address long-neglected challenges so our country can thrive in the 21st century.

As part of the Recovery Act, the NIDCD received approximately \$100 million to be used in Fiscal Years 2009 and 2010. A significant portion of dollars will be awarded to supplement existing NIDCD grants, thus helping to stimulate the economy by accelerating the pace of NIDCD-funded research. The NIDCD received nearly 1,000 applications, which were evaluated by numerous NIDCD staff and members of the National Deafness and Other Communication Disorders Advisory Council.

An exciting category within the ARRA administrative supplements provides funding for summer research experiences for students and science educators. These supplements give currently funded NIDCD researchers the opportunity to encourage students to pursue research careers in the health-related sciences, as well as provide teachers and university faculty members of all levels with short-term research experiences in NIH-funded laboratories. The NIDCD has funded 37 such awards, which are going to 19 states for up to two years. In all, NIH has awarded roughly 5,100 positions in all 50 states and the District of Columbia and Puerto Rico.

For up-to-date information, including a map and a detailed state-by-state listing of summer supplements awarded by the NIH, check the new Research Portfolio Online Reporting Tool (RePORT) on the Web at <http://report.nih.gov/recovery/arrasupplements.cfm>.

## Meetings of Interest

### Acoustic Neuroma Association 19th National Symposium

August 14-16, Chicago, Ill.

The Acoustic Neuroma Association's biannual symposium offers educational lectures, workshops, panel discussions, and networking for pre- and post-treatment acoustic neuroma patients, family members, friends, and health care professionals. Learn about acoustic neuromas from medical experts and patients. For more information, check the organization's Web site at <http://www.anausa.org/symposium.html>.

### Academy of Rehabilitative Audiology (ARA) 2009 Annual Institute

September 10-11, Bettendorf, Iowa

ARA promotes excellence in hearing care by providing comprehensive rehabilitative and habilitative services. For more information about the meeting, visit their Web site at <http://www.audrehab.org>.

### American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) Annual Meeting and OTO EXPO 2009

October 4-7, San Diego, Calif.

AAO-HNS's Annual Meeting and OTO EXPO 2009 is the world's largest gathering of otolaryngologists. More than 6,000 professionals from around the world, including physicians, researchers, and nurses, will review the latest research findings, earn continuing medical education credits, network with colleagues, and visit the most extensive state-of-the-art exposition of products and services of its kind. Check their Web site at [http://www.entnet.org/annual\\_meeting/index.cfm](http://www.entnet.org/annual_meeting/index.cfm).



## National Recreation and Park Association (NRPA) Congress and Exposition

October 13-16, Salt Lake City, Utah

The NRPA Congress and Exposition provides access to education opportunities, networking events, exhibitors, and business-critical information to thousands of park and recreation leaders, advocates, partners, and suppliers. Check the NRPA's Web site at <http://www.nrpacongress.org/display.asp?eid=2&id=5>.

## Society for Neuroscience (SfN) Presents Neuroscience 2009

October 17-21, Chicago, Ill.

Neuroscience 2009, the 39th annual meeting of the Society for Neuroscience, offers lectures, symposia, and continuing medical education for scientists at all career stages. Check the society's Web site at <http://www.sfn.org/am2009>.

## ASPEN's Annual Fall Conference

October 23, Iselin, N.J.

ASPEN is a national voluntary nonprofit association to educate, support, and advocate for families and individuals living with autism spectrum disorders. For more information about the fall conference, visit their Web site at <http://www.aspennj.org>.

## American Public Health Association (APHA) Annual Meeting and Exposition

November 7-11, Philadelphia, Pa.

APHA's 137th Annual Meeting and Exposition offers the opportunity to learn from the experts in the public health field about cutting-edge research and best practices, products, and services. APHA's meeting program addresses current and emerging health science, policy, and practice issues in an effort to prevent disease and promote health. Learn more at the association's Web site at <http://www.apha.org/meetings>.

## American Speech-Language-Hearing Association (ASHA) Convention

November 19-21, New Orleans, La.

This year's convention theme is "Two Professions: Powerful Partners." The convention offers professional and scientific development with cutting-edge presentations and exhibits. Learn more at ASHA's Web site <http://www.asha.org/events/convention>.

## Beyond NIDCD: News from Other Organizations

### Summer Issue of *Hearing Health* Features NIDCD's Noisy Planet Campaign

*Hearing Health*, the quarterly magazine produced by the Deafness Research Foundation, highlights the NIDCD's *It's a Noisy Planet. Protect Their Hearing* campaign in its summer issue. The foundation is collaborating with the campaign to help spread the word about the importance of protecting our hearing. The magazine is available by subscription or you can access the latest issue for free on the Web at <http://www.drf.org/magazine>.



## The Holley Institute Gets New Name to Reflect New Programs

After 16 years, the Holley Ear Institute has become the Holley Institute. The new name takes into account their expanded programming that includes persons experiencing hearing and vision loss.

Upcoming programs at their facilities in Michigan include:

- *Volunteer Week*, August 16-21. Adults who are deaf and ages 18 and older are invited to volunteer 4-5 hours a day beautifying the facilities and grounds.
- *Healthy Language—Healthy Future*, September 18-19. For families with toddlers (between the ages of 1 and 3) who are deaf or hard-of-hearing.
- *Deaf Cancer Survivors Weekend*, October 23-25.

To learn more, visit their Web site at [www.stjohn.org/holley](http://www.stjohn.org/holley).

## Vestibular Disorders Association (VEDA) Balance Awareness Week September 20-26

The Vestibular Disorders Association (VEDA) celebrates the 13th annual Balance Awareness Week, September 20-26. The week was established in 1997 to raise awareness about the importance of balance and inner-ear health to a person's general well-being and quality of life. For more information check the association's Web site at <http://www.vestibular.org>.

## Central Institute for the Deaf Offers Workshops and New Spanish-language Resources

The Central Institute for the Deaf offers four workshops on auditory-oral deaf education at its facilities in St. Louis, Mo. Courses are at the intermediate or professional level, and are accredited for ASHA continuing education units (CEUs).

- *Targeting Speech Skills for a Child Who Is Deaf or Hard-of-Hearing: From Assessment to Intervention*, September 25.

- *Early Intervention for Children with Hearing Impairment*, October 21.
- *SPICE: Auditory Management of Children with Cochlear Implants and/or Hearing Aids*, October 22-23.
- *Listen, Talk and Learn in Pre-K: Designing a Program for Preschool Children Who are Deaf or Hard-of-Hearing*, November 6.

To register or for more information, contact Dianne Gushleff at [dgushleff@cid.edu](mailto:dgushleff@cid.edu) or call (314) 977-0133. Or visit their Web site at <http://www.cid.edu/home/fallworkshops.htm>.

CID also offers a Spanish-language version of two checklists to help parents and teachers learn how to care for children's hearing aids and cochlear implants. Each 6"x9" magnet includes tips of what to do in the morning and at bedtime. You can order them on the Web at <http://www.cidedu.com>.

## New Resources from the Stuttering Foundation

The Stuttering Foundation has new resources available on its Web site at <http://www.stutteringhelp.org>.

- *Stuttering: Myths, Beliefs, and Straight Talk*. Targets teens and dispels some of the myths surrounding this complex disorder. Free to download at <http://www.stutteringhelp.org/Default.aspx?tabid=708>.
- *The Child Who Stutters: To the Pediatrician*, 4th revised edition, by Drs. Edward G. Conture and Barry Guitar. Includes a risk factors chart and physicians' checklist for referral. Free to download at <http://www.stutteringhelp.org/Default.aspx?tabid=12>.
- *Tools for Success: A Cognitive Behavior Therapy Taster*. This DVD explores the interaction of thoughts, feelings, physical reactions, and behaviors from the perspectives of children, parents, and therapists. It discusses and demonstrates ways to use the cognitive model. To buy a copy of the DVD visit their Web site at <http://www.stutteringhelp.org/Default.aspx?tabid=748>.



## New Resources

### NIDCD Offers New Resources on Voice

The NIDCD offers new information resources on voice for the general public, patients and their families, and health care professionals.

Watch NIDCD program director Lana Shekim, Ph.D., discuss how voice is produced, what makes voices different, how the voice becomes damaged, what careers may make us more prone to voice problems, things we can do to protect our voices, and research that the NIDCD is funding to help prevent and treat voice damage (5 min.). The video is available at <http://www.nidcd.nih.gov/about/video/InterviewLanaShekimFull.htm>.

Read an interview with NIDCD-funded researcher Ingo R. Titze, Ph.D., a distinguished professor who has studied the human voice for more than 30 years. Also, watch a video of his performance with Pavarobotti, a voice simulator/singing robot created by Dr. Titze and colleagues. The interview is available at <http://www.nidcd.nih.gov/about/video/titze.htm>, and the video at <http://www.youtube.com/watch?v=UQw03TXZsHA>.

### Noisy Planet Campaign Introduces "Feature Guest"



Matthew W. Kelly, Ph. D.

The NIDCD's Noisy Planet campaign has added a new "Featured Guest" section on its Web site. The featured guests can be anyone who has an interest in hearing protection—from biomedical researchers to concerned parents to savvy kids. The section will include a short interview in which each guest will share his or her point of view on questions related to hearing and hearing protection.

The first featured guest is NIDCD research scientist Matt Kelley, Ph.D. Dr. Kelley's lab explores how the inner ear develops in mammals. Watch the video (6 min.) at [http://www.noisyplanet.nidcd.nih.gov/info/featured\\_mattkelley](http://www.noisyplanet.nidcd.nih.gov/info/featured_mattkelley).

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**Voice: (800) 241-1044**  
**TTY: (800) 241-1055**  
**E-mail: [nidcdinfo@nidcd.nih.gov](mailto:nidcdinfo@nidcd.nih.gov)**